REMARKS

This responds to the Office Action mailed on July 14, 2006.

Claim 28 is amended and no claims are added. Claims 21, 26 and 78 have been withdrawn from consideration. As a result, claims 23-25 and 27-29 are pending examination in this application.

The Objections to the Drawings and Specification as to New Matter

The Office Action introduced a new basis for objection to the drawings submitted in the last amendment, filed March 22, 2006, and introduced an objection to the specification based on that amendment on the asserted basis that the amendment introduced new matter into the disclosure. The Office Action indicated a requirement to cancel the new matter from the specification. However, as will be set forth in more detail below, such cancellation is not necessary or appropriate. As both objections are based on essentially the same question of new matter, they will be addressed together.

The previously submitted correction to Figure 4 inserted spacers into the regions housing the liquid semiconductor in the depicted cell, in accordance with the disclosure of Claim 27, as well as of other claims currently withdrawn from consideration. The amendment to the specification indicated that the spacers "are placed into abutment between the Ohmic contact 10 and the Schottky contact 30 to maintain the channel between the two contacts so that they do not touch each other."

The Office Action states that there is "no basis for indicating the spacers are positioned where they are, oriented the way they are, the number of spacers should be limited to that shown, or that the spacers "abut" the contacts. Applicants respectfully point out that Figure 4 is not a mechanical depiction of a cell in accordance with the present invention, but is a schematic depiction. Accordingly, no inference is intended, and none should be implied, as to any precise structure, such as the "positioning", "orientation" or "number" of the contacts. Further, a "spacer" between two elements is not performing the function of spacing those two elements unless at some point, the spacer contacts or "abuts" those two elements. Such a spacer may

provide some reassurance that spacing will be maintained at least at the height of the spacer in the absence of actual contact. But the actual "spacing" function of a "spacer" only happens when the elements which are being "spaced" actually contact the spacer.

The Office Action speculated about various hypothetical aspects of the disclosed "spacers," none of which were germane to subject matter disclosed in the application as filed or the amendments made. The mere fact that one can conceive of all sorts of unrelated questions to raise about spacers does not in any way support that the subject matter depicted in amended Fig. 4 or added to the specification is new matter.

The amendment to the drawings and the accompanying amendment to the specification merely depict and recite, respectively, the inherent function and placement of the "spacers" as disclosed in the originally-filed claims. Such inherent disclosure is expressly permitted without violating the prohibition against adding new matter. *See* MPEP §2163.07(a):

> By disclosing in a patent application a device that inherently performs a function or has a property, operates according to a theory or has an advantage, a patent application necessarily discloses that function, theory or advantage, even though it says nothing explicit concerning it. The application may later be amended to recite the function, theory or advantage without introducing prohibited new matter. [citations omitted]

It is hard to imagine a function more readily apparent than that of a "spacer" spacing apart two elements by contacting them, particularly in a schematic depiction. Applicants thus submit that the subject matter added to the drawings and to the specification is not new matter, and thus each is a permissible amendment in view of the guidance of the MPEP. *See also* MPEP §2163.07. Applicants thus request that the objections to the drawing and to the specification on the basis of new matter be withdrawn.

The Objections to the Specification under 35 U.S.C. §112

The objections to the specification under §112 are not expressly set forth in the current Office Action of July 14, 2006. The current Office Action refers back to the objections of paragraphs 4e and 4g in the Office Action of November 22, 2005. Applicant does not see that

any revisions to those rejections have been made, and thus understands the current objections to the specification to still be as follows:

> 4e) "There is no adequate description nor enabling disclosure of how and in what manner "persons familiar with the art" are to select the materials of construction of the entire invention in order to operate as disclosed. Applicant again has stated the desired results of the materials to be selected, for example, pp 13, lines 12-17, "as <u>persons familiar with the art will understand</u>, the Ohmic Contact is preferably made from a metal such that no, or a minimal barrier, exists between the Ohmic Contact 10 and the Liquid Semiconductor 20. Furthermore, as persons familiar with the art will understand, the Schottky Contact 30 is preferably made from a metal such that when placed in contact with the Liquid Semiconductor 20 a substantial electrostatic barrier is created across the Liquid", however it is not seen wherein specific examples of materials that accomplish the desired effect are disclosed. It is not seen wherein specific materials that are compatible with each other so is to present an operative embodiment are disclosed, hence the disclosure is insufficient and nonenabling."
>
> 4g) "There is no adequate description nor enabling disclosure of the overall dimensions of the invention. Page 13 lines 22-25 disclose that the cross-section of the strata making up the act of parts of the invention are .0163 cm however it is not seen where other dimensions are disclosed to present an operative embodiment. There is also no adequate description of how and in what manner the device can be scaled up to the systems disclosed in, for example figures 9-11 including exactly how and in what manner the liquid semiconductor can be forced to flow through the nuclear voltaic cells in a useful manner."

In the current Office Action, the Examiner further stated as follows regarding the objections of paragraphs 4e and 4g:

> Applicant makes general allegations that those in the art would know what materials to select and that the overall dimensions would vary depending upon the application, however then later states that those in the "liquid semiconductor and direct energy conversion sciences" would not obviously arrive at the instant invention because of the issues surrounding liquid semiconductors and page 41 "the interdependencies of all the variables are quite complex."
>
> This appears to set forth that those in the art do not know what materials to use or the manner to combine them. Applicant may not be required to produce a production specification however the statute requires the application itself to inform, not to direct others to find out for themselves. *In re Gardiner et al.* 166 U.S.P.Q. 138, *In re Scarbrough,* 182 U.S.P.Q 298. Note that the disclosure must enable a person skilled in the art to practice the invention without having to design structure not shown to be readily available in the art; *in re Hirsch*, 131 U.S.P.Q 198.
>
> Again, if applicant is of the opinion that those in the art do indeed know what materials and inventions would be required to produce an operative embodiment, then he

> should have submitted evidence in support thereof. General allegations are of no probative value.

Applicants respectfully submit that the above objections are applying a standard that is not in accordance with the controlling legal authority as to the appropriate interpretation and application of §112, first paragraph. Further, for the reasons that will be set forth below, Applicants respectfully submit that the above objections should be withdrawn because: (1) the Office Action fails to establish the required *prima facie* case of failure to comply with the written description requirement; (2) the Office Action similarly fails to establish the required *prima facie* case of non-enablement; and (3) an assertion of non-enablement is not supported by fact or law.

Applicants will first address Applicants' statements quoted in the Office Action (and quoted herein, above), which the Office Action is tacitly attempting to use as admissions in purported support of the enablement rejection. As will be set forth below, the statements: (1) have been taken out of context; and (2) are simply not probative on the point for which they are relied upon in the Office Action. The linking of the statements in the Office Action above removes the statements from the actual context of describing why persons in the fields of liquid semiconductor and direct energy conversion sciences would not be lead to discover Applicants' invention; and attempts to give weight to the statements in inappropriate support of the objection based on non-enablement. As set forth below, the two inquiries are legally very different and distinct.

First, Applicants would like to clarify the context of the statements made that have been relied upon in the current Office Action in reasserting this objection. In Applicants' response to the prior Office Action, submitted March 22, 2006, the phrase "liquid semiconductor and direct energy conversion sciences," as quoted in the Office Action, is found only on page 42, the third full paragraph. That paragraph, in context, is indicating why the paths of investigation in these two fields would not render obvious the subject matter of Applicants' claims. That full paragraph reads as follows:

> The liquid semiconductor and direct energy conversion sciences are the only two approaches an investigator could reasonably take to discover Applicant's

> invention. However, the studies in liquid semiconductors are not focused to answer most of the questions that a direct energy conversion researcher would seek to have answered. They are mostly interested in pure scientific or academic pursuits, or to improve applications in the current semiconductor sciences. This leaves the nuclear scientists with little to consider when choosing a semiconductor for his device. The more clever could consider the amorphous state, but it is not obvious that anyone of ordinary skill in the nuclear art would consider the use of a liquid instead of a solid. They are more likely to be interested in a self healing solid than a self healing liquid.

Thus, in context, Applicants are explaining why an investigator would not arrive at the conclusion of Applicants' invention, and in particular, Applicants are identifying the non-obviousness to one of skill in the nuclear arts ("nuclear scientists") to use a liquid semiconductor instead of a solid semiconductor in the context of Applicants' invention.

The other phrase cited in the Office Action, from page 41 of the response, is directed to the complications in selecting a liquid semiconductor, as recited in each of Applicants' claims. That entire passage with emphasis on the language quoted in the Office Action is as follows:

> The use of liquid semiconductors however has many complications associated with it. As illustrated in the pervious [sic: "previous"] liquid semiconductor section the studies do not offer much information relevant to direct energy conversion investigators. Before a direct energy conversion scientist can seriously consider the concept behind Applicant's invention, they must first begin to research into the chemical, physical and nuclear properties of the liquid semiconductors. Many of the variables a liquid semiconductor scientist develops in his experiments shift or change when factoring in the neutronics and stopping power of a material. For example, densities now become a much more complex issue. Most solid materials become <u>less</u> dense when in liquid form, particularly materials that retain semiconductor properties (like the chalcogens). Thus, <u>Brown</u> teaches away from liquid semiconductors because <u>Brown</u> espouses <u>higher</u> density for more efficient energy capture (column 10, lines 51-54). If we consider all the factors that effect efficiency, density is not a primary concern. However, density can favor the nuclear considerations depending on the system configuration. *The interdependencies of all of the variables are quite complex.*

Thus, read in context, it is clear that Applicants are describing why the use of a liquid semiconductor has associated complications, including those relating to the evaluation of the chemical, physical and nuclear properties of the liquid semiconductors themselves; and thus why it is not an obvious leap for a direct energy conversion investigator to elect to use liquid

semiconductors, particularly in view of the teachings in the primary reference of the Office Action, the Brown patent.[1] In both passages above, Applicants' comments are clearly directed to the liquid semiconductors themselves, and to the non-obviousness of using them.

The question of whether or not an invention is enabled is an entirely different inquiry from whether the invention is obvious or not. The inquiry on obviousness is whether one of skill in the pertinent art would have found the invention obvious based upon the prior art. The inquiry on enablement is whether persons skilled in all the various pertinent arts would be enabled to practice the invention, once those persons have not only the knowledge of all the prior art, but also the insights and teachings of the Applicants' disclosure. Contrary to the assertions implicit in the Office Action, Applicants' statements, discussed above, do not in any way suggest that persons of skill in all the pertinent arts would not know what materials to use or how to combine them—once they were informed to use a liquid semiconductor (for example, liquid selenium), and the types of contacts to establish with that liquid semiconductor. This will be addressed in more detail below.

I. The Objections Based On Written Description

The literal language of the Examiner's objections recited above indicates an asserted absence of "adequate description," suggesting that an objection on that basis is intended. Nevertheless, Applicants cannot tell if such a rejection was actually intended. Certainly no specific statements other than the broad assertion, have been made.

As is well-known, the written description of §112, first paragraph, is separate and distinct from the enablement requirement. *See* MPEP § 2163, and cases cited therein. The obligation imposed by the written description requirement is that the specification must describe the invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. *Id.*

[1] Applicants' disclosure addresses this issue for persons in the art, by describing at least one satisfactory liquid semiconductor for use in the described cells, liquid selenium.

There is no indication in the Office Action of subject matter in the claims that is not sufficiently disclosed for one skilled in the art to appreciate that Applicants were in possession of the subject matter recited in the claims. If such an objection is intended, the Examiner has the initial burden, by a preponderance of the evidence, of establishing why a person skilled in the art would not recognize in Applicants' disclosure a description of the invention as defined by the claims. *See* MPEP §2163.01)(III)(A).

Specifically, as indicted in the MPEP, in order to reject a claim on the basis of no adequate written description, the examiner "must set forth express findings of fact" which should: (1) identify the claim limitation at issue: and (2) establish a *prima facie* case by providing reasons why a person skilled in the art at the time the application was filed would not recognize that the inventor was in possession of the invention as claimed in view of the disclosure of the application as filed. *Id.*

Since no showing of this type was presented in the Office Action, Applicants assert that, no *prima facie* case of an absence of adequate written description has been established. Moreover, Applicants further respectfully submit that in view of the correspondence between the pending claims and the specification, there can be no question that those skilled in the art would recognize that the Applicants were in possession of the claimed invention at the time the application was filed. Thus, to the extent that any objection based on written description under §112 was intended, such objection should be withdrawn.

II. The Objections Based on Asserted Non-Enablement Under §112, First Paragraph

Applicants will first address the state of the law regarding enablement under §112, and will then address the specific objections quoted above.

A. The Legal Precedent on Enablement and Rejections Based Thereon

It seems useful to establish a common reference of the state of the law on enablement under §112, first paragraph. The Federal Circuit has instructed us as follows:

> [a] specification disclosure which contains a teaching of the manner and process of making and using the invention in terms which correspond in scope to those used in describing and defining the subject matter sought to be patented *must* be taken as in compliance with the enabling requirement of the first paragraph of §112 *unless* there is reason to doubt the objective truth of the statements contained therein which must be relied upon for enabling support… [a]ny party making the assertion that a US patent specification or claims fails for one reason or another to comply with §112 bears the burden of persuasion in showing said lack of compliance.

Fiers v. Sagano, 25 USPQ 2d 1601, 1607 (Fed. Cir. 1993) (*quoting In re Marzocchi*, 169 USPQ 367, 369 (CCPA 1971) (emphasis in original).

Thus, there is a clear presumption that a submitted specification is enabling.

Further, as is well known, the standard on enablement under §112 is that the claimed invention be enabled so that persons skilled in the art can make and use the invention without undue experimentation. *See In re Wands* 8 USPQ 2d 1400, 1404 (Fed. Cir 1998); *see also United States v. Telectronics*, Inc., 8 USPQ 2d 1217, 1223 (Fed Cir 1988); (both as cited in MPEP §2164.01). Thus, the test for enablement expressly contemplates that some selection and/or experimentation may be required. It is further clear that the fact that experimentation may be complex does not necessarily make it undue if the art typically engages in such experimentation. *See* MPEP § 2164.01, and *In re Certain Limited-Charge Cell Culture Microcarriers,* 221 USPQ 1174 (Int'l Trade Comm'n 1983), as cited therein. It is also significant when evaluating the question of enablement which may involve different scientific disciplines, that the specification is enabling if it enables those skilled in the art to carry out the different aspects of the inventions applicable to their specialty. MPEP §2164.05(b), citing *In re Naquin*, 158 USPQ 317, 319 (CCPA 1968).

Importantly, precedent is also clear that an applicant's burden to disclose only goes to that subject matter which is new. That subject matter which is conventional knowledge to those skilled in the art will be read into the disclosure. *See In re Howarth*, 210 USPQ 2d 689 (CCPA 1981). As stated in *In re Howarth*:

> [i]t is well settled that the disclosure of an application embraces not only what is specifically set forth in words or drawings, but what would be understood by persons skilled in the art. As was said in *Webster Loom Co. v. Higgins et al.*, 105 U.S. 580, 586 the applicant "may begin at the point where his invention begins,

> and describe what he has made that is new and where it replaces of the old. That which is common and well known is as if it were written out in the patent and delineated in the drawings.

Id at 691.

Thus, subject matter which would be known to those skilled in the relevant arts is not required to be disclosed in an application, for the invention to be enabled.

B. The Legal Standard for Establishing a *Prima Facie* Case of Non-Enablement

The MPEP is instructive in terms of the establishing of a *prima facie* case of unpatentability based on enablement, and the factors to be considered. Section 2164.01(a) identifies, in a "non-exhaustive list," eight factors to be considered when determining whether sufficient evidence exists to support a determination that a disclosure does not satisfy the enablement requirement, and whether any necessary experimentation is undue. As stated in this section of the MPEP, these factors include, but are not limited to:

(a) the breadth of the claims
(b) the nature of the invention
(c) the state of the prior art
(d) the level of one of ordinary skill
(e) the level of predictability in the art
(f) the amount of direction provided by the inventor
(g) the existence of working examples; and
(h) the quantity of experimentation needed to make or use the invention based on the content of the disclosure.

See also In re Wands, 8 USPQ 2nd 1400, 1404 (Fed Cir 1988).

It is also clear, and pertinent to the present issues, that a *prima facie* case of non-enablement must be established by the patent examiner. As we are guided by the Federal Circuit in *In re Wright*, 27 USPQ 2d 1510, 1513 (Fed. Cir. 1993) (emphasis added):

> When rejecting a claim under the enablement requirement of Section 112 the [Patent Office] bears an initial burden of setting forth a reasonable explanation as to why it believes that the scope of protection provided by the claim is not adequately enabled by the description of the invention provided in the specification of the application; this includes, of course, providing sufficient reasons for doubting any assertions in the specification as to the scope of enablement.

We are further guided by the Federal Circuit: that "[t]he initial determination by the patent examiner is critical to further proceedings, for the presence or absence of a prima facie case... controls the need for the Applicant to adduce rebuttal evidence..." *In re Dillon*, 16 USPQ 2d 1897, 1908 (Fed Cir 1990) (en banc) (Newman, J. sitting) (*cert. denied sub nom. Dillon v. Manbeck*, 500 US 904 (1991). *see also In re Angstadt*, 1990 USPQ 214, 219 (CCPA 1976) (*citing In re Armbruster*, 185 USPQ 152 (CCPA 1975) ("We note that the PTO has the burden of giving reasons supported by the record as whole, why the specification is not enabling.... Showing that the disclosure entails undue experimentation is part of the PTO's initial burden....").

The MPEP, in §2164.04 compiles the above principles, and is very specific as to the Examiner's burden to establish a prima facie case of non-enablement (emphasis in original):

> While the analysis and conclusion of a lack of enablement are based on the factors discussed in MPEP §2164.01(a) and the evidence as a whole, it is not necessary to discuss each factor in the written enablement rejection. The language should focus on those factors, reasons, and evidence that lead the examiner to conclude that the specification fails to teach how to <u>make and use</u> the claimed invention without <u>undue experimentation</u>, or that the scope of any enablement provided to one skilled in the art is not commensurate with the scope of protection sought. This can be done by making specific findings of fact, supported by the evidence, and in drawing conclusions based on these findings of fact.

<u>C. The Current Objections Based on Enablement</u>

Applicants respectfully point out that under the above controlling legal precedents, the Office Action has not met its initial burden of establishing a *prima facie* case of non-enablement as to either of the two asserted points; and further, there is no legally supportable basis for such an assertion to be made. Applicants will address the two objections individually.

a. <u>The Objections of Paragraph 4e</u>

<u>1. No Prima Facie Case of Non-enablement Has Been Established</u>

In this objection, in the Office Action of November 22, 2005, the Office Action stated that there is "no adequate description or enabling disclosure" of how and in what manner "persons familiar with the art" are to select the materials of construction of the entire invention in

order to operate as disclosed. Although the Office Action refers to "the entire invention," the only actual issues identified are as to the materials of the metal contacts for the ohmic contact 10 and the Schottky contact 30, as described by Applicant. No further issues have been identified, much less addressed in accordance with the instructions of MPEP 2164.04(a), as identified above. Applicant therefore must assume that the objection, in reality, relates solely to the selection of materials for these two contacts.

Further, even as to these two elements, the Office Action is completely silent as to any substantive rationale for why selection of appropriate materials for these two elements would not be able to be performed by one skilled in the art without undue experimentation. Because there is no rationale given for the assertion, there is not even a defined point for Applicants to seek to rebut. Accordingly, Applicants submit that the Office Action fails to establish the required *prima facie* case of non-enablement in the objection of paragraph 4e.[2]

2. The Invention Is Enabled Under §112

Applicants further submit that there is no legally supportable basis upon which a rejection on the asserted grounds could be established. First, Applicants' disclosure should be presumed to be enabling, and in the absence of specific information indicating to the contrary, must be considered to be enabling. *See Fiers v. Sagano*, 25 USPQ2d at 1607, as quoted above.

Applicants have already discussed why the passages from Applicants' prior response identified in the current Office Action do not support the position for which they were presumably cited. Such passages do not stand for any proposition supporting an assertion of non-enablement. Since those passages address only the question of what would be obvious to "one of ordinary skill in the art," to rebut an obviousness rejection, they are not probative to what

[2] The Office Action stated in reference to both paragraphs 4e and 4g, that "...if applicant is of the opinion that those in the art do indeed know what materials and dimensions would be required to produce an operative embodiment, then he should have submitted evidence in support thereof." However, clearly, as here, where no prima facie case of non-enablement has been established, then no burden of submitting such evidence can exist. *See In re Dillon*, 16 USPQ 2d at 1908 cited above (The initial determination by the patent examiner is critical to further proceedings, for the presence or absence of a prima facie case... controls the need for the Applicant to adduce rebuttal evidence...."). Nevertheless, Applicants submit herein evidence from the record of why an assertion of non-enablement is inappropriate in view of the legal requirements for such.

would be known or enabled to persons of skill in the various arts applicable to making and using the invention as claimed, once they had the benefit of Applicants' disclosure. *See* discussion of MPEP 2164.05(b), above.

Further, and importantly, even if we were to assume--solely for purposes of argument--that Applicants' quoted statements in some way suggested an absence of knowledge of persons skilled in the art regarding the identified subject matter, any such suggestion would be expressly rebutted by information already of record in the file history. For example, it is well known in the prior art of record to establish both ohmic and Schottky contacts with a semiconductor material. For example, the Brown patent, relied on in the Office Action as the primary reference in the rejection under §103, expressly discloses forming an "ohmic contact" between the disclosed electrode (5) and electronegative region (2). *See* Brown, col. 6, lines 14-16. Additionally, the Examiner has taken the position that "Brown inherently has Schottky contacts wherever metal directly contacts the semiconductor." While Applicants submit that this issue is not as simplistic as presented by the Examiner (as addressed below), taken at face value the Examiner construes Brown to disclose both an ohmic contact and a Schottky contact. Yet Brown does not disclose the material to be used for either contact. And Brown must be presumed to have been issued in accordance with all statutory requirements, including those of 35 USC § 112, first paragraph. So at a minimum, even Brown clearly indicates that it was known to those skilled in the art to make both ohmic and Schottky contacts to a semiconductor, and that disclosure of particular materials was not required for enablement.

It is just as well known to make both ohmic and Schottky contacts to a semiconductor with a metal. The Office Action seems to suggest that a metal can establish only a Schottky contact with a semiconductor.[3] However, a suggestion that any contact between a metal and a semiconductor is a Schottky contact, is incorrect. Any such suggestion would ignore the physics realities well known to those skilled in the art. Although, broadly stated, a Schottky barrier is

[3] Asserting such a position seems to be the only basis for the citation of Denninger in the prior art rejections, as addressed later herein.

formed when a metal contacts a semiconductor; those skilled in the art are well aware that the characteristic of the contact may be adjusted as desired for a specific application.

Rather than refer to a simplistic lesson plan outline (as in Denninger), Applicants draw the Examiner's attention to one of the well-known textbooks in the field, "Physics of Semiconductor Devices," by S.M. Sze, Second Edition, 1981 ("Sze").[4] Sze includes an entire chapter (chapter 5) entitled "Metal-Semiconductor Contacts," and devoted to that topic. While Applicants will not seek to summarize the teachings of the entire chapter (which is submitted with an IDS, which will be submitted shortly following this response), certain points are illustrative that ohmic metal-semiconductor contacts are well-known to those skilled in the art. In sub-chapter 5.2 (printed page 246), Sze includes a section entitled "Energy Band Relation," and states: "[w]hen metal is making contact with a semiconductor, a barrier will be formed at the metal-semiconductor interface." In sub-chapter 5.3, entitled "Schottky Effect," Sze discusses that barrier, and the Schottky effect. That barrier is discussed extensively in subsequent sub-chapters. Sze then includes an entire sub-chapter 5.7, entitled "Ohmic Contact" (printed page 297), which he starts by defining that "[a]n ohmic contact is defined as a metal-semiconductor contact that has a negligible contact resistance relative to the bulk or spreading resistance of the semiconductor." Sze then goes on to discuss the current transport mechanisms in such metal-semiconductor contacts under various conditions, and includes a figure (Fig. 43) depicting theoretical and experimental values of specific contact resistance. In reference to that figure, Sze states: "…high doping concentration, low barrier height, or both must be used to obtain low values of R_c [contact resistance]. And these are exactly the approaches used for all ohmic contacts… [referencing Fig. 44]."

Thus, it is clear that persons skilled in the art were well aware of making ohmic contacts between metals and semiconductors over 20 years prior to Applicants' filing of the present application.

[4] Although there is a more recent third edition of this textbook, Applicants cite to the edition from 1981, over 20 years prior to the filing date of the present application.

The Office Action has not suggested that there is a difference between the establishing of a contact between a metal and a liquid semiconductor, and the establishing of a contact between a metal and a solid or amorphous semiconductor. To the contrary, in the rejections over prior art, the Office Action has relied upon the teachings relative to solid semiconductors to be instructive to those skilled in the art as to the establishing of contacts with liquid semiconductors. Applicants wish to make clear that they do not assert that any fundamental distinction exists, though they do submit that, as evidenced by Sze, the considerations regarding contacts between a metal and a semiconductor, solid or liquid, are not nearly as simplistic as suggested in the Office Action.

Further, in accordance with the legal guidance outlined above regarding enablement, the complete body of prior art knowledge in the selection of materials, and particularly, of metals, to make such types of contacts with a semiconductor material as might be desired, are available to provide enablement of Applicants' invention. See again the instruction, quoted above, from *In re Howarth:*

> That which is common and well known is as if it were written out in the patent and delineated in the drawings.... Thus, clearly, subject matter which would be known to those skilled in the art is not required to be disclosed in an application, for the invention to be enabled.

Howarth, 210 USPQ at 692.

Given that body of knowledge, some of which is expressly relied upon by the Examiner, there is no evidence in the record known to Applicants to suggest that persons of skill in the pertinent arts would not be able to select materials, including metals, to establish the described ohmic and Schottky contacts. Additionally, Brown, the primary reference cited by the Examiner further supports that such selections of materials would be within the level of skill of those in the art by virtue of both: (1) the teachings which the Examiner ascribes to the reference, and (2) the absence in the presumptively valid Brown patent of any disclosure of materials for the described contacts. Further, the capability of establishing contacts of the identified types between a metal and the semiconductor is further supported by the discussions of Sze. Accordingly, Applicants request that the objections to the specification on this basis be withdrawn.

b. The Objections of Paragraph 4g

The substance of the objections under paragraph 4g are stated above. As best as Applicants can interpret the stated reasoning, there are two issues asserted: (1) some undefined scope of dimensions allegedly necessary to present an operative embodiment; and (2) some "manner" by which the liquid semiconductor can be "forced to flow through the nuclear voltaic cells in a useful manner." Applicants respectfully assert that the Office Action fails to establish a *prima facie* case of non-enablement as to either basis; and further assert that no finding of non-enablement could be appropriate here, as will be demonstrated below.

1. No *Prima Facie* Case Of Non-Enablement Has Been Established

As identified in Applicants' response filed March 22, 2006, the present invention is directed to a liquid semiconductor nuclear voltaic cell, which, as is readily apparent to those skilled in the art, can vary in size and configuration depending upon the specific application, and the structures and materials selected for that application. Also as noted in the response, Applicants' specification and Figure 1 describe the dimension quoted by the Examiner for the operative portions of an example embodiment of a nuclear voltaic cell.

As a first and critical matter, it is not apparent from the objection exactly which dimension or dimensions are asserted to be beyond the level of skill of those persons skilled in the various arts applicable to practicing the invention. It is manifestly clear that an application is not required to be a blueprint, and thus not all dimensions to make a device are required. *See Christianson V. Colt Industries*, 3 USPQ 2d 1241 (Fed. Cir 1987) (vacated on other grounds, 486 U.S. 800 (1988). But the Office Action fails to identify even a single dimension which is allegedly beyond the ability of those of ordinary skill in the pertinent technology to supply without undue experimentation. This failure to specify which dimension(s) is considered to be lacking presents an inappropriate and unfair burden on Applicants, as Applicants are not in a position to even address the issue with any specificity. Further this failure is completely inconsistent with the Examiner's burden to establish a *prima facie* case of non-enablement with specific reasoning, findings of fact, etc.. Such a *prima facie* case has not been established, as required by the MPEP. *See* MPEP §2164.01(a); and pages 25-28 herein.

2. Evidence Of Record Supports That There Is No Basis For This Rejection

Applicants respectfully submit that the specificity suggested in the Office Action is not required by the enablement requirement of §112; as such information is clearly information which would be known to persons of skill in the appropriate arts, or could be determined by those persons without undue experimentation. Again, this position is directly supported by information already in the file history.

Applicants refer the Examiner to the Kherani patent relied upon in the Office Action. Again, by virtue of being an issued U.S. patent, this patent is presumed to meet the enablement requirements of §112, as well as all other statutory requirements. Kherani discloses a nuclear battery using a solid semiconductor. What Kherani does not disclose, of course, is any suggestion to use a liquid semiconductor in such a nuclear battery.

Kherani provides little in the way of dimensions. Relative to the described nuclear cell, Kherani describes that the thickness of the a-SiT region (the intrinsic region (18) of the disclosed p-i-n diode) is on the order of 0.2μm. *See* Kherani, col. 5, lines 1-10. The only other dimension identified is further in that same column where the patent discusses exemplary power calculations for one exemplary cell, wherein there is a mention of that same intrinsic region being 1μm in thickness, with the p and n regions being "in comparison...quite thin". Beyond such dimensions, there appear to be no additional dimensions of Kherani's described nuclear battery.

Similarly, the Examiner's attention is drawn to the Cota '505 patent, also of record in this application. Cota describes a "self sustaining power module" that incorporates a radioactive source such as tritium with a voltaic cell to produce a self-sustaining power source. *See* Cota, title and col. 1, lines 5-10. The Cota patent provides no dimensions whatsoever of the described power module. The only inference of any dimension whatsoever in Cota is relative to Figures 17 and 21, which depict what appears to be a handle for a power pack having multiple cells therein. The apparent handle is labeled "56" but is not identified or addressed in the specification. This

presumptively valid and statutorily-compliant issued U.S. patent again reflects that in technologies generally related to the field of Applicants' invention, dimensions, at least beyond the general type of dimensions already provided by Applicants' disclosure, simply are not required for enablement.

The Office Action also states that there is "no adequate description of how and in what manner the device can be scaled up to the systems disclosed in, for example Figures 9-11, including exactly how and in what manner the liquid semiconductor can be forced to flow through the nuclear voltaic cells in a useful manner." Once again, Applicants must respectfully submit that a patent disclosure is not required to be a blueprint for others but merely a disclosure sufficient to guide those having the skills of those in the relevant arts to create the claimed invention. *See Christianson V. Colt Industries*, *supra.* And once again, Applicants must respectfully submit that the Office Action fails to establish a *prima facie* case of non-enablement, as there is no indication as to what aspect of combining nuclear voltaic cells toward a structure such depicted in Figures 9-11 would be beyond what could be achieved by persons skilled in the pertinent arts without undue experimentation, or what perceived aspect of causing liquid semiconductor flow is allegedly beyond the capabilities of those persons to achieve without undue experimentation.

Further, as to the combination of multiple nuclear voltaic cells as described relative to Figure 9 and the creation of fluid flow paths, such issues seem manifestly to be issues only of relatively straightforward mechanical engineering, such that Applicants cannot adduce what problem the Examiner perceives could be beyond the abilities of persons skilled in the relevant arts to solve without undue experimentation. Applicants again refer to the MPEP, §2164.04, entitled "Burden on the Examiner Under the Enablement Requirement":

> A specification disclosure which contains a teaching of the manner and process of making and using an invention in terms which correspond in scope to those used in describing and defining the subject matter sought to be patented must be taken as being in compliance with the enablement requirement of 35 U.S.C. §112, first paragraph unless there is a reason to doubt the objective truth or the statements contained therein which must be relied upon for enabling support.
> . . .

> It is incumbent upon the Patent Office, whenever a rejection on this basis is made to explain <u>why</u> it doubts the truth or accuracy of any statement in a supporting disclosure and to back up assertions of its own with acceptable evidence or reasoning which is inconsistent with the contested statement. <u>Otherwise there would be no need for the Applicant to go to the trouble and expense of supporting his presumptively accurate disclosure</u>....
> According to *In re Bowen*...the minimal requirement is for the Examiner to give reasons for the uncertainty of the enablement. This standard is applicable even when there is no evidence on the record of operability without undue experimentation beyond the disclosed embodiments.

Clearly no such showing has been made. But more importantly, no such showing would be appropriate. As to any aspect of the identified invention, persons skilled in the art pertinent to any specific implementation issue, including the engineering of cell construction and fluid flow, have available to them the complete body of prior art for solving such issues. In the case of the objections under paragraph 4g, the issues generally raised in the Office Action seem to be merely issues of straightforward mechanical engineering of a type inherent in designing any such structure, once those persons have the guidance of Applicants' disclosure as to the novel structure which is to be formed.

Accordingly, for all the reasons set forth above, Applicants submit with all due respect that the present specification is in fact enabling, and that the issues raised by the Examiner simply do not rise to the level of creating a prima facie case of non-enablement of Applicants' specification. At a bare minimum, the rejection fails to identify any essential parts or relationships or other information which is allegedly missing, and to provide any reason why one skilled in the art could not supply that information without undue experimentation. In fact, other issued patents in related technologies directly support Applicants' position that the level of skill of persons in the related technologies are in fact adequate for others to be enabled to make and use Applicants' invention, once they have the benefit of Applicants' present disclosure. Accordingly, Applicants respectfully request the Examiner's reconsideration and withdrawal of these objections under 35 U.S.C. §112.

The Rejection of Claim 28 under 35 U.S.C. § 112

The current Office Action also maintained the rejection of claim 28 under 35 USC §112, second paragraph, from the prior Office Action as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. That original rejection stated as follows:

> Claim 28 is vague, indefinite and incomplete in what all is met by and encompassed by the phrase "said liquid semiconductor flows between said first metallic contact layer and said second metallic contact layer" because the limitation "flows" does not connote any particular "flow" per se. The limitation "flows between" is considered to incorporate flow back and forth from one contact to another as well as straight through the channel that is bounded on either side by the contacts, hence the metes and bounds of the claim are undefined.

In the current Office Action, the following response to Applicants' arguments was presented:

> Regarding section 6e and the language of Claim 28 it is noted that the previous rejection is still pertinent since the channel separates the contact the layers and the semiconductor must actually flow through the channel between the contact layers in order to travel from one contact layer to the other, not necessarily in one side and out the other side of the channel.

Applicants must first point out that the Office Action did not accurately recite the language of claim 28. What the claim actually said, prior to the current amendment, was: "said liquid semiconductor flows <u>in the channel</u> between said first <u>metal</u> contact layer and said second <u>metal</u> contact layer." Further, with all due respect, the above comments seem to be directed to either forcing Applicants to claim the invention more narrowly than they desire, or to imposing unstated and unintended interpretations onto the existing language. Either would be inappropriate. There was no statement included, and no suggestion intended, in claim 28 as to any direction or property of such liquid semiconductor flow.

However, to make this claim even more clear, Claim 28 has been amended to delete the phrase "between said first metal contact layer and said second metal contact layer." As the channel is defined in claim 27, from which claim 28 depends, as being "between said first metal contact layer and said second metal contact layer," there is no need for this restatement of the channel placement to be repeated in claim 28. Thus, as the language complained of in claim 28

has been deleted, Applicants submit that any possible basis for the rejection of claim 28 under §112 has been cured. Applicants therefore request the reconsideration and withdrawal of the rejection.

The Rejection Of Claims 23-25, 27 And 28 Under §103

Claims 23-25, 27 and 28 were rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 6,118,204 to Brown in view of either Denninger or U.S. Patent No. 5,606,213 to Kherani et al., and further in view of any of U.S. Patent No. 5,260,621 to Little et al., Godlezsky et al., Yu et al., Kulkarni et al., Price et al., Matthiesen et al., or Enderby et al.

In reaffirming the rejection, the Examiner stated that Applicants' arguments previously submitted in the prior response are "unpersuasive as Applicant has not shown that the references do not teach what the Examiner has stated they teach, nor has Applicant shown that the Examiner's reasoning for and manner of combining the teachings of the references is improper or invalid". The Examiner also stated that "Applicant's arguments failed to comply with 37 C.F.R. 1.111(b) because they amount to a general allegation that the claims define a patentable invention without specifically pointing out how the language of the claims patentably distinguishes them from the references." The Office Action then goes on to specifically discuss the allegations regarding the Brown reference.

Applicants wish to first address the above statements in the Office Action. Applicants submitted numerous arguments regarding the impropriety of the combining of the prior art references as suggested by the Examiner in reaching the conclusion of obviousness presented in the Office Action. In any rejection based on a combination of references, for the rejection to present the required *prima facie* case of obviousness, the references must each be in an "analogous art," that is, they must be either within the field of the Applicants' endeavor, or they must be pertinent to the particular problem with which the inventor was concerned. *See* MPEP §2141.01(a). Further, once it is determined that all the references applied in the combination are analogous art, there must be some suggestion or motivation to combine the teaching of the references in the combination. *See* MPEP §2143.

Accordingly, Applicants' arguments in the prior response regarding the art to which persons of skill in different arts would look when attempting to reach a solution in the field of Applicants invention go directly to the question of whether the prior art relied upon is "analogous art". Similarly, the presented discussions of individual references went directly to the limited teachings of many of the references, and the resulting absence of a suggestion or motivation to combine those references to achieve Applicants' invention. Accordingly, the previously-submitted arguments do in fact go to the propriety of the obviousness rejection, and thus to "the distinctions believed to render the claims...patentable," under 37 C.F.R. §1.111(b) Therefore, the statement that the prior response was not in accordance with that rule is in error.

The only direct response submitted in the Office Action to Applicants' prior arguments about the impropriety of the combination is the statement "in this case, it is known in the art to use semiconductors and as admitted by Applicant in the last 40 years, many properties of liquid semiconductors have been tested, examined, discovered, documented, etc., and the Examiner has set forth how this knowledge was generally available to one of ordinary skill in the art." Applicants must make two points in response. First, although Applicants do not dispute the general accuracy of the above statement, Applicants' specific "admission" in the response was only that "[s]cientists have been familiar with liquid semiconductors for over forty years...;" and in the specific statements in Applicants' comments regarding the prior art references. Second, Applicants respectfully submit that although the above statement from the Office Action is generally true, that in no way either: (1) establishes any cooperative teaching between the references which establish a *prima facie* case of obviousness, or (2) provides any meaningful rebuttal to any of Applicants' arguments presented as to the propriety of that combination. The mere fact that different liquid semiconductors and many of their properties were known does not serve to make the required suggestion of the use of those materials in combination with the teachings of other references. Applicants will further address the absence of the required cooperative teaching more completely in the following paragraphs.

I. The Disclosures Of The Individual References

Applicants will first provide comments as to the teachings of the references cited in the rejection.

A. Brown and Kherani

Brown discloses a power cell for directly converting ionizing radiation into electrical energy. *See* Brown, col. 3, lines 52-55. That power source includes: (1) an electronegative material layered in a semiconductor to form a first region (N-layers region) that has a high density of conduction electrons; (2) an electropositive material also layered in the semiconductor material to form a second region (P-layers region) with a high density of holes; and (3) a neutral zone of semiconductor material doped with radioactive isotope such as tritium separating the N-layers region and the P-layers region. *See* Brown col. 3, lines 52-65. Current is generated in the disclosed cell by the difference in work functions between the electropositive region 3 in the semiconductor material and the electronegative region 2 in the semiconductor material. This is expressly stated at column 6, lines 46-61. In evaluating the structure of Brown in accordance with the level of those skilled in the art, it is clear that the potential difference of Brown is not tied to any material difference between the two exterior electrodes 5 and 6; but rather is tied to the difference in work functions between the two semiconductor regions 2 and 3 to which they are coupled. This difference will cause a current flow between the outer semiconductor regions and the two exterior electrodes 5 and 6 attached thereto.

For sake of clarity, it should be pointed out that in two locations Brown speaks in opposition to the above disclosure, and states that the "potential gradient across the neutral zone is provided by the difference by the Fermi energy levels of the electronegative and electropositive electrodes." *See* Brown, col. 3, line 66 to col. 4, line 1. Brown has a similar statement in column 6, lines 62-65, that the "resulting potential difference between the two electrodes 5 and 6 [each of which is exterior to the semiconductor regions] is equal to the difference in their work functions, i.e., the Fermi potential difference." However, as is apparent to those skilled in the art, neither of these statements is literally correct, at least in the references to the "electrodes."

That understanding of the structure and operation of the Brown device is significant. However, the significance is not as to the connections established with the semiconductor material, as discussed in the rejection. Rather, the understanding that is significant is of the type of device actually disclosed by Brown, and the constraints upon it.

To one skilled in the art, it is apparent that Brown discloses a structure based upon a p-i-n junction. This type of device is formed by a neutral zone of semiconductor material (region 4, in Brown) which is contained between n-layers and p-layers of semiconductor material (regions 2 and 3 in Brown). For reference, Applicants draw the Examiner's attention to the Kherani patent which discloses the described "nuclear batteries" in embodiments of both a p-n junction and a p-i-n junction. The latter p-i-n embodiment is similar in basic structure and operation to that described in Brown. *See* Kherani, Figure 4 and discussion relating thereto. In Kherani, the device is described in terms of a p-type tritiated amorphous carbon region 21, a n-type tritiated amorphous silicon region 22, and an intrinsic tritiated amorphous silicon region 25 between the two. Kherani also states "the semiconductor junction may be either the p-n or the p-i-n type with an intrinsic or near intrinsic region disposed between the p and n (regions)." *See* Kherani, col. 2, lines 38-40. Kherani thus fully demonstrates and supports Applicants' position that to one skilled in the art the Brown patent teaches a p-i-n structure formed by Brown's layers 2, 3 and 4.

The absence of importance of the material of the electrodes to the structures disclosed by Brown is further highlighted by the embodiment of Figure 3 wherein Brown depicts an "isotropic electric converter cell" provided with a capacitor assembly 24. As can be seen in Figure 3, and affirmed by the accompanying disclosure found in column 8, lines 1-23, that structure discloses the energy converter cell 23[5] which includes the n and p doped semiconductor regions separated by the neutral zone ("semiconductor medium 27") having a radioactive isotope dispersed therein, but wherein no separate electrodes are included within the structure. As that description makes clear, "an ionizing flux, preferably beta particles, ionize the atoms of the semiconductor medium 27 generating hole pairs which are swept away by the electric field produced by the Fermi

[5] There is an error in the Brown specification, as both the electric converter cell and the capacitor are identified as "23" in Figure 3 and in the accompanying discussion.

potential difference between the electronegative and electropositive regions." No electrodes are described or illustrated in the embodiment.

For sake of clarity, Applicants point out that some structure forming an electrical connection is going to be required to establish the conduction paths between layers 26 and 28 and the capacitor structure in Figure 4. But clearly, any such electrodes and any properties they may have are not significant to the function and operation of Brown's energy converter cell, or such would have been illustrated and described. Applicants submit that those skilled in the art recognize that the same considerations are applicable to the embodiment of Figure 4, which depicts electrodes, but with the current going straight to a load rather than to a storage capacitor as in the embodiment of Figure 3.

Referring now again to the Kherani reference, already discussed above, Kherani discloses a nuclear battery formed of three regions, such as a P region of tritiated amorphous carbon, a N region of tritiated amorphous silicon and a central "intrinsic" region of tritiated amorphous silicon. *See* Kherani, col. 6, lines 24-32. As noted above Kherani's specific contribution to the art was the use of a material such as amorphous silicon because it could form p-i-n junctions with a minimum of recombination centers. This reduction of density of recombination centers was perceived to be useful to increasing the excess carrier lifetime and the nuclear cell current *See* Kherani, col. 3, lines 55-65.

The prior Office Action stated that Kherani is "similar with Brown," in that both Brown and Kherani were represented to teach that "the nuclear cell potential is essentially varied by the work function of Fermi level of the selected semiconductors." Applicants agree with this analysis. In that Office Action, Kherani was then further asserted to teach that "the cell potential and power characteristic can be further extended by the use of metal semiconductor junctions…." Kherani does contain some disclosure of further increasing the nuclear cell potential and power characteristics by the use of Schottky barrier junctions. *See* Kherani, col. 6, lines 57-65. However, it is clear that the basic structure of Kherani's proposed p-n or p-i-n junction device remains the same, whether or not such contacts are added to the basic structure.

B. Denninger

Denninger is relied upon in the Office Action to establish the proposition that " a Schottky contact is formed any time there is direct contact of a metal with a semiconductor." As might be expected with any such simplistic statement about semiconductor physics, such a statement is both true and misleading.

As noted previously herein, there is some barrier formed whenever there is direct contact between a metal and a semiconductor. *See* Sze at p. 246. This is sometimes referred to as a Schottky barrier[6], or as exhibiting a Schottky effect. However, those skilled in the art are aware that such effects may or may not be desired, and are aware of how to design a contact to either fully realize, or to minimize Schottky effects. *See* discussion of Sze at page 31 herein.

Thus, Denninger seems pertinent only in overly generalizing the far more complex topic of contacts between metals and semiconductors, as is actually understood by those skilled in the art. But regardless of whether Denninger is combined with Brown or not, the remaining references in the combination simply do not provide the missing teaching towards Applicants' invention.

C. The Third Tier of References to Little, Godlezsky, Yu., Kulkarni, Price, Matthiesen and Enderby

The above references are each relied upon individually for the apparent purpose of setting forth "benefits of liquid semiconductors over solid semiconductors." One issue as to many of the references, that Applicants elected to not belabor in their prior response, but will address now, is that several of these references do not provide any meaningful teaching as to liquid semiconductors as disclosed by Applicants, and as known to those skilled in the art. Those references simply do not stand for the principles for which they are asserted in the Office Action. The remaining references simply do not provide any cooperative teaching with Brown or

[6] *See* e.g., McGraw-Hill Dictionary of Scientific and Technical Terms, 2nd Ed, 1978 ("**Schottky barrier** [ELECTR] A transition region formed within a semiconductor surface to serve as a recifying barrier at a junction with a layer of metal.

Kherani suggesting their combination. Each reference in this third tier of the rejection will be addressed below.

1. Little

Little is directed to a radio-nuclide, voltaic-junction battery The described battery includes a number of power cells of the type shown in and discussed relative to Figs. 2 and 3 of the reference. *See* Little, col. 2 lines 46-68; col. 3, line 52 to col. 4, line 5. Little discloses that each cell includes five "stratum," formed of three wafers. The outermost of the three wafers are each implanted on one side to form a P region, and on the other to form a N region. Between those wafers is the third, which includes a nuclide emitter statum. *Id.* As a full reading of Little makes clear, a primary concern is use of a material in the nuclide emitter stratum that can heal from the defects of radiation damage that will naturally result from operation of the cell. *See* Little, col. 4, line 8 to col. 6, line 63. In the described system of Little, this is addressed through selection of semiconductor materials that will anneal at sufficiently low temperatures that they will be self-healing to at least some of the above defects. *See* Little, col. 6, lines 19-42.

It must be noted that Little is express in teaching away from systems in which impurities implanted in the regions to form p-n junctions would "diffuse throughout the material…thereby rendering the device useless." *Id.* Such diffusion would be inherent in a molten or liquid semiconductor. Thus, Little expressly teaches away from use of semiconductors in liquid form It is well-known to those skilled in the art that "annealing," as described by Little, is expressly distinct from reducing a material to a molten state.[7] Thus Little not only fails to teach use of liquid semiconductors, it expressly teaches away from their use, as semiconductors in a liquid state would destroy the usefulness of the disclosed device.

[7] *See* e.g., A New Dictionary of Physics, J. Gray and A. Isaacs, ed., Second Edition, 1975, p. 23 ("**annealing** The process of heating a substance to a specific temperature lower than its melting point, maintaining that temperature for some time and then cooling slowly. Slow crystallization thus takes place in the solid state under controlled temperature conditions. Annealing generally softens metals and stabilizes glass articles by allowing stresses produced during fabrication to disappear.")

2. Godlezsky, Yu, Kulkarni and Matthiesen

As will be set forth below, these references are not instructive on the points for which they are asserted in the Office Action.

a. Godlezsky

Godlezsky seeks to provide an explanation for the phenomenon observed experimentally that "[a]ll semiconductors of group IV such as silicon,[8] and III-V materials…assume metallic behavior when melted," in "contrast to some II-IV semiconductors such as CdTe which retain their semiconducting properties in both the liquid and the solid state." *See* Godlezsky, Abstract. Thus, the premise of the disclosed analysis is based on a recognition that some semiconductors (group IV and III-V materials) become metallic when melted, while some others do not.
The Office Action specifically cited Godlezsky (specifically referring to page 4962, first column, 3rd full paragraph), as teaching "that increased temperatures causes [sic] a denser six fold coordinated structure. (Note the teaching of Brown with regard to density)."

However, Godlezsky does not support the point for which it is cited. The relevant passage in Godlezsky regarding the quoted language includes the sentence preceding the quoted language and the sentence containing it:

> In IV or III-V semiconductors, with higher temperatures, entropy favors a disordered and close-packed structure (entropy is larger for such configurations). Consequently, a transition occurs from a fourfold structure to a more randomly mixed and denser sixfold coordinated structure.

Thus, read in context, such passage is not discussing reactions of materials that are semiconductors in a liquid state. Rather, it is specific in discussing the reactions of those materials expressly identified as exhibiting metallic properties in the liquid state (all semiconductors of group IV and III-V materials, as expressly identified in the reference). Thus, Godlezsky does not stand for the proposition for which it is cited.

[8] Germanium is also a group IV material.

b. Yu

Yu is directed to a study of the surface tension and surface profile of Si and Ge, and their alloys in molten form. *See* Yu, Abstract. Yu does not ever represent that any of these materials are semiconductors in such liquid form, or evaluate their conductive properties in liquid form. In fact, Yu uses the term "liquid semiconductors" only twice: in the title of the article, and in the caption to Fig. 3. Moreover, other references of record (such as Godlezsky, above), make clear that neither Si nor Ge (both Group IV materials) exhibit semiconductive properties in their liquid state. Thus, Yu is simply not instructive on liquid semiconductors as disclosed and claimed by Applicants, and as known to those skilled in the art pertinent to Applicants' invention.

c. Kulkarni

Kulkarni again discusses the properties of liquid germanium. In agreement with Godlezsky, Kulkarni is express that liquid germanium is not a liquid semiconductor: "[u]pon melting, Ge undergoes a semiconductor-metal transition accompanied by significant structural changes." Kulkarni goes on: "[s]imilarly, the electrical conductivity increases on melting by more than an order of magnitude, to about $1.6x10^{-4}\,\Omega^{-1}\,cm^{-1,2}$ a range characteristic of metallic behavior." Thus, Kulkarni is express that the described diffusion studies are not of a material that is a liquid semiconductor, but a metal. Accordingly, whether or not Kulkarni provides the teachings identified in the Office Action regarding diffusion, any such teachings are simply not pertinent to liquid semiconductors or to Applicants' invention.

d. Matthiesen

Matthiesen is stated to be "similar to Kulkarni et al. in teaching that the diffusion process in liquid semiconductors is important because of the desire for uniform diffusion of dopants (impurities)." Of course, as established above, Kulkarni is only addressing liquid germanium, and by its own express language is therefore addressing only a molten semiconductor with metallic properties, not a liquid semiconductor. Matthiesen is similarly limited, in that it again addresses pure liquid germanium as well as liquid germanium containing various levels of dopants. *See* Matthiesen, page 5, last paragraph. Thus, the reference again provides no additional teaching of pertinence to the present inquiry.

Moreover, Matthiesen actually discloses an experiment to be performed on the space shuttle to examine the process of diffusion in semiconductor melts. *See* Matthiesen, page 1, third paragraph. As such, there is no reason one would expect persons skilled in the art facing the challenge of designing an improved nuclear voltaic cell, as were Applicants, to have ever looked at Matthiesen. Applicants can see no rationale why a description of an experiment for the space shuttle for pure academic research on dopant diffusion in molten semiconductors would be pertinent to the analysis of any such persons.

Moreover, there is no reason why one facing the problem being addressed by Applicants would be motivated to look at any of Godlezsky, Yu, Kulkarni or Matthiesen. If any one of these has any relevance whatsoever to Applicants invention (which is doubtful), it is not to properties of liquid semiconductors useful to a person seeking to design an improved nuclear voltaic cell. Further, none provides any teaching which can be combined with any reference in the first two tiers of references (Brown, then Denninger or Kherani), to suggest Applicants' invention. Thus, any combination in the obviousness rejection on bases including these references fails to establish a *prima facie* basis for the rejection. For at least this reason, Applicants request the reconsideration and withdrawal of the rejections based on these references.

3. Price and Enderby

a. Price

Price, unlike some of the references discussed above, does at least address, in part, liquid semiconductors. The reference is relied upon in the Office Action as teaching:

> ...that within 30 different semiconductors there is generally a significant increase in conductivity from the solid to liquid state. A significant increase in conductivity is a benefit because decreasing resistive losses within the semiconductor material causes an increase in efficiency of the device.

The first statement is at least correct, in that Price does show that within the discussed semiconductors, many exhibit a significant increase in conductivity. The second sentence quoted from the Office Action indicates that this is beneficial, as it would "increase efficiency". In fact,

nothing could be further from the truth, and the statement indicates a misunderstanding of the prior art and/or of the invention.

Price discloses that for a large group of semiconductors, including the group IV and the III-V semiconductors, the increase in conductivity is sufficient to push those materials into the metallic region. *See* Price, p. 2, discussion of Fig. 1. As discussed above, and also as indicated by Yu, Godlezsky and Kulkarni, in this circumstance the materials no longer function as semiconductors. Thus, rather than such liquid materials being of "increased efficiency" in a device as disclosed by Applicants, they would be useless in such a device, as they are no longer semiconductive materials, and the device would no longer function.

Thus, Applicants do not see what Price discloses of pertinence to Applicants' invention, other than the very basic point that some but not all semiconductor materials exhibit semiconductive properties in the liquid state. Price certainly does not support the conclusions stated in the Office Action. Price also again does contain any disclosure that suggests its combination with the references of the first and second tier references.

b. Enderby

Enderby addresses many aspects of liquid semiconductors. The only basis stated in the Office Action for the citation of Enderby is as follows:

> Enderby et al. is a quite comprehensive report on liquid semiconductors reiterating many of the benefits already disclosed in the preceding references including that some semiconductors change from semi conductive to semi metallic at certain temperatures. This is considered beneficial in that using a specific semiconductor with a specific transition temperature within the operating range of the nuclear voltaic cell would be considered self regulating by temperature, i.e. as the cell was operating and the temperature continued to increase, the decay of the fuel, at the point that the semiconductor transitions to semi metal the Fermi functions would change causing less electrons to reach the electrodes and a subsequent decrease in current which could be used to signal an over temperature condition necessitating increased cooling requirements or shutdown.

Applicants are at a loss to understand how the above statements in the Office Action are pertinent to the Enderby reference or to the propriety of its combination with other of the applied references. For example, the operation of a "specific semiconductor" with a solid-liquid transition temperature within (or below) the operating range of the cell is not "beneficial" in terms of the claimed invention, it is essential-as otherwise the semiconductor material would not even be continuously in the liquid phase. Even more importantly, the operation of a "specific semiconductor" with a transition from a semiconductive state to a semi-metallic state is not "beneficial" in a device in accordance with the claimed invention, as proposed in the Office Action, because it would render the device non-functional. Such a transition would, by definition, destroy the very semiconductive properties for which the material was included in the device.

Applicants are further at a loss to understand the purported relevance of the discussion regarding using a decrease in current "to signal an over temperature condition necessitating increased cooling requirements or shutdown." Such statements appear completely unrelated to the claims or to any possible suggestion for combination of Enderby with other references. Applicants submit that there is no disclosure in Enderby of pertinence, other than a general discussion of properties of liquid semiconductors. Applicants further submit that there has been no indication of any suggestion or motivation to combine Enderby with the references of the first two tiers to achieve Applicants' invention.

II. There Is No Motivation or Suggestion To Combine The Applied References To Achieve Applicants' Invention

Applicants have addressed this point in several of the individual discussions of the references above. Applicants would now, however, like to step back and look at the field of the references as a whole, because the most fundamental suggestion—that to use a liquid semiconductor in a cell of Brown, or even Kherani, is simply not present. As a result, the asserted combinations must fail.

The current Office Action appears to set forth a position, in essence, that merely because liquid semiconductors were known, there was some suggestion or motivation in the prior art to use them in combination with the teachings of Brown:

> In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where these is some teaching, suggestion, or motivation to do so found either in the cited references themselves or in the knowledge generally available to one of ordinary skill in the art.[citations omitted] In this case, it is known in the art to use semiconductors and as admitted by applicant, in the last 40 years the properties of liquid semiconductors have been tested, examined, discovered and documented, etc. and the examiner has set forth how this knowledge was generally available to of ordinary skill in the art.

Office Action at p. 6.

However, the required teaching or suggestion acknowledged to be required for such a rejection is simply not present. Any such suggestion could only be found in an impermissible hindsight reconstruction based on Applicants' disclosure. *See In re Fine*, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988) ("One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."). When such suggestion or motivation is not presented in a rejection, there is a presumption that the combination was selected through hindsight. *See In re Rouffet,* 47 USPQ 2d 1453, 1458 (Fed. Cir. 1998) ("Because the Board did not explain the specific understanding or principle within the knowledge of a skilled artisan that would motivate one with no knowledge of Rouffet's invention to make the combination, this court infers that the examiner selected these references with the assistance of hindsight. This court forbids the use of hindsight in the selection of references that comprise the case for obviousness.").

If we look again at Brown and Kherani, as discussed above, both describe voltaic cells having a solid semiconductor configured to establish an N region and a P region, separated by a nuclearly active, relatively undoped region, forming a p-i-n device. In both devices, the difference between the work functions of the N and P-doped semiconductor regions results in a current flow across the device.

Brown specifically addresses the placement of metallic foils in the outermost regions of the solid semiconductor in order to adjust the work functions in these semiconductor regions to improve functioning of the device. Thus, Brown specifically teaches away from adopting a structure in which (a) a single semiconductor region is used, (b) wherein the semiconductor is incapable of maintaining distinct and contrasting doped regions, and/or (c) wherein such metallic foils could not be used to adjust the work function of those contrasting doped regions on each side of the relatively undoped region. Thus, Brown expressly teaches away from the use of liquid semiconductors on at least these three bases.

Kherani is slightly different, but no more instructive in the direction of Applicants' invention. Kherani's contribution was in the use of an amorphous semiconductor, such as amorphous silicon, to contain a tritium dopant in a nuclear cell, and particularly in a configuration of a p-i-n cell. Note that Kherani expressly discloses that one reason for using amorphous silicon is that it was known to be advantageous in forming p-i-n junctions with a minimum of recombination centers, which were useful to increasing the excess carrier lifetime and the nuclear cell current *See*, Kherani, col. 3, lines 59-65. So the entire reason for Kherani's contribution was to improve the performance of a p-i-n junction cell, with its required three regions, as described. Accordingly, by disclosing a device which requires a semiconductor region with 3 distinct and individually doped regions, Kherani again expressly teaches away from use of a liquid semiconductor.

Accordingly, there is no indication in either of these references, or seen in any of the references cited in the third tier of combined references, as to why one having a device which only functions with three or more distinct doped regions would be motivated to look to liquid semiconductors, which are manifestly unable to maintain such separate regions. Accordingly, there is no hint of any motivation to make the combination of Brown with any reference, other than possibly Kherani. Although there is not even any apparent suggestion of any reason those two references might be combined, such a combination is at least not directly contrary to the teachings of the other reference.

But any further combination with any of the references of the third tier of references, as proposed in the Office Action, with the possible sole exception of Little, would require a person to abandon the fundamental structure of Brown, and even the theory of operation of the disclosed device. There simply is no suggestion in the references of that third tier, purported to show awareness of liquid semiconductors (though as set forth above, several clearly do not), that would instruct one having knowledge of Brown or Kherani that he or she should ignore the teachings of those references, and move to use of another material, the use of which is fundamentally inconsistent with the devices of those references in both structure and theory of operation. As to that sole exception, Little, it does not disclose liquid semiconductors, which is the reason it does not in direct opposition to the devices based on p-i-n junctions. But Little again only teaches a device having multiple and distinct semiconductor regions, as do Brown and Kherani, and thus again teaches directly away from use of liquid semiconductors. Little thus fails to teach or suggest Applicants' invention, even if it is combined.

Accordingly, the proposed combination of the applied references fails to establish any prima facie case of obviousness; and no such case can be established based on an appropriate review and consideration of the applied references. Applicants therefore request the reconsideration and withdrawal of this rejection, and the passing of these claims to allowance.

The Rejection Of Claim 29 Under 35 USC §103

Claim 29 was rejected on the same basis applied to claims 23-25, 27 and 28, further in view of Knight. Claim 29 is dependent from Claim 23, which Applicants believe has been shown to be allowable over the applied references. Accordingly, Applicants submit that claim 29 is allowable at least as depending from an allowable independent claim, as set forth above. Applicants therefore request the reconsideration and withdrawal of this rejection, and the passing of this claim to allowance.

CONCLUSION

Applicants respectfully submit for all the reasons set forth above, that it has been shown that there are no bases for objection to the specification; and that all claims are fully allowable over the art, and thus in condition for allowance; and notification to that effect is earnestly requested. Applicants thank the Examiner in advance for careful consideration of the arguments presented herein addressing the issues raised in the Office Action.

The Examiner is invited to telephone Applicants' undersigned attorney at (512) 628-9324 if there are any matters which may be resolved or clarified through telephone interview to advance prosecution of this application and the passing of this case to issue. In the event that after review of this Response, the Examiner believes there are any matters yet to be resolved before the passing of this application to issue, Applicants respectfully request an interview with the Examiner prior to the issuance of another Office Action. Such interview may be arranged through Applicants' undersigned attorney at the number indicated.

If necessary, please charge any additional fees or credit any overpayments to Deposit Account No. 19-0743.

Respectfully submitted,
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By their representatives,

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Date: 12/14/2006

By ____________________
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CERTIFICATE UNDER 37 CFR 1.8: **The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web, and is addressed to: Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on this 14th day of** December 2006.

Kimberly Brown — Kimberly Brown

Name — Signature